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August 25, 1997

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Subject: Catawba Nuclear Station
Docket No. 50-414
LER 414/97-006

Gentlemen:

Attached is Licensee Event Report: **Manual Reactor Trips Following Main Steam Isolation Valve Closure**.

This event is considered to be of no significance with respect to the health and safety of the public.

Very truly yours,

G. R. Peterson
Site Vice-President

Attachment

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AUTH.NAME AUTHOR AFFILIATION
BIRCH,M.L. Duke Power Co.
PETERSON,G.R. Duke Power Co.
RECIP.NAME RECIPIENT AFFILIATION

SUBJECT: LER 97-006-00:on 970726,manual reactor trips occurred due to closure of MSIV 2SM-1.Caused by failure of digital optical isolator (DOI) within control circuitry of MSIV 2SM-1. Replaced failed DOIs & improved DOI testing.W/970825 ltr.

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LICENSEE EVENT REPORT (LER)

APPROVED OMD NO. 3150-0104
EXPIRES: 04/30/98
ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNBB 7714), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Catawba Nuclear Station	05000414	1 of 9

TITLE (4)
Manual Reactor Trips Following Main Steam Isolation Valve Closure

EVENT DATE (5)			LER NUMBER (6)					REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR		SEQUENTIAL NUMBER		REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER(S)
											Not Applicable	05000
7	26	97	97	-	006	-	00	8	25	97		05000

OPERATING MODE (9)	1	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR (Check one or more of the following) (11)					
POWER LEVEL 10)	100	20.402(b)	20.405(c)	X	50.73(a)(2)(iv)		73.71(b)
		20.405(a)(1)(i)	50.36(c)(1)		50.73(a)(2)(v)		73.71(c)
		20.405(a)(1)(ii)	50.36(c)(2)		50.73(a)(2)(vii)		OTHER (Specify in Abstract below and in Text, NRC Form 366A)
		20.405(a)(1)(iii)	50.73(a)(2)(i)		50.73(a)(2)(viii)(A)		
		20.405(a)(1)(iv)	50.73(a)(2)(ii)		50.73(a)(2)(viii)(B)		
		20.405(a)(1)(v)	50.73(a)(2)(iii)		50.73(a)(2)(x)		

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER	
	AREA CODE	
ML Birch, Safety Assurance Manager	(803)	831-3310

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	
F	SB	OB	E169	Yes							

SUPPLEMENTAL REPORT EXPECTED (14)			EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE)	X	NO				

ABSTRACT *(Limit to 1400 spaces, i.e. approximately fifteen single-space typewritten lines)* (16)

Unit Status: Unit 2 was in Mode 1, Power Operation, at 100% power.

Event Description: On July 26, 1997, at 2223 hours, and on August 17, 1997, at 0130 hours Unit 2 was manually tripped to preclude an automatic trip following closure of Main Steam Isolation Valve (MSIV) 2SM-1. During both events all safety systems responded as designed. Auxiliary Feedwater (CA) automatically started upon receipt of a low steam generator (S/G) level signal to maintain S/G level. Emergency Core Cooling System (ECCS) actuation was not necessary and did not occur. A second CA autostart occurred during the August 17 event when the level in the S/G isolated by 2SM-1 closure inadvertently decreased below the low level setpoint.

Root Cause: The cause of both manual reactor trips is attributed to failure of a digital optical isolator (DOI) within the control circuitry of MSIV 2SM-1. The July event involved the "A" train circuitry and the August event involved the "B" train circuitry.

Corrective Action: Operations personnel correctly diagnosed each event and tripped, evaluated and stabilized Unit 2 per station procedures. Failed and suspect DOIs have been replaced. An improved method of testing DOIs for the identified failure has been developed. All DOIs in MSIV applications have been tested and will receive additional testing. All DOIs in critical control applications with the same model number as the DOIs noted in this LER and having AC input and DC output will be tested. Additional failure analysis by vendors is being performed to identify the failure mechanism internal to the DOI. Engineering will review the results of the failure analysis and recommend additional corrective actions as necessary.

BACKGROUND

The Main Steam (SM) system [EIIS:SB] conveys steam from the steam generators [EIIS:SG] to the high pressure turbine [EIIS:TRB]. Installed in each of the four SM lines is a Main Steam Isolation Valve (MSIV) [EIIS:ISV]. The Unit 2 MSIVs are identified as 2SM-1, 2SM-3, 2SM-5, and 2SM-7. MSIVs are normally open, pneumatically controlled, fail closed valves which close on a SM isolation signal to stop uncontrolled steam flow from the steam generators in the event of a break in the SM piping. This prevents excessive cooldown and the resulting positive reactivity insertion.

Digital optical isolators [EIIS:OB] (DOIs)are used in the control circuitry of the MSIVs to provide physical and electrical isolation between input and output signals. This isolation establishes and maintains separation of Class 1E equipment from non-Class 1E equipment.

The Feedwater (CF) system [EIIS:SJ] supplies feedwater to the four steam generators at the required temperature, pressure, and flow necessary to maintain the proper steam generator water level.

The Auxiliary Feedwater (CA) system [EIIS:BA] provides emergency feedwater to the steam generators to maintain secondary side level at times when normal feedwater is not available. The CA system has two train related motor driven pumps [EIIS:P] and one turbine driven pump.

Procedure EP/2/A/5000/E-0, Reactor Trip or Safety Injection, is used by Operations personnel to verify proper response of automatic protective systems following a reactor trip or safety injection.

EP/2/A/5000/E-0.1, Reactor Trip Response, is used by Operations personnel to stabilize and control the plant post trip. EP/2/A/5000/E-0 transitions to EP/2/A/5000/E-0.1 if the unit trip did not involve or require a safety injection.

EVENT DESCRIPTION

July 26, 1997

2222:57 hours Annunciator [EIIS:ANN] "SM Isolation Valves Not Fully Open" was received in the control room. Reactor operators confirmed that MSIV 2SM-1 was closing.

2223:07 hours	The Operator at the Controls (OATC) immediately initiated a manual reactor trip to preclude an automatic trip. All control rods fully inserted.
2223:08 hours	The main turbine automatically tripped on the reactor trip signal.
2223:15 hours	The motor driven CA pumps autostarted due to receipt of a low steam generator level signal.
2223:24 hours	CF supply to the steam generators isolated due to receipt of a reactor trip with low Reactor Coolant (NC) system [EIIS:AB] average temperature signal.
2223:26 hours	The turbine driven CA pump autostarted due to receipt of a low steam generator level signal. Immediately following the manual reactor trip, Operations personnel entered procedure EP/2/A/5000/E-0 to verify proper response of the automatic protective systems. Transition to EP/2/A/5000/E-0.1 occurred to stabilize and control the plant. Unit 2 was stabilized in Mode 3, Hot Standby.
~2350 hours	The Failure Investigation Process (FIP), a systematic approach to identify potential equipment failure modes, was initiated to determine the cause of MSIV 2SM-1 closure.
July 27, 1997	
1647 hours	Engineering and Maintenance reviewed and tested the operation of all components in the MSIV control circuitry. A failed optical isolator, 2SMID1 (CZ), in the "A" train circuitry was identified.
2320 hours	Maintenance replaced the failed optical isolator per Work Order 97064125-01. Functional testing verified proper operation of 2SM-1 control circuitry. Maintenance and Engineering tested the optical isolators in the control circuitry of the remaining Unit 2 MSIVs. The optical isolators were operating normally with no signs of degradation.

July 28, 1997

0343 hours — Unit 2 was returned to operation.

August 17, 1997

0130 hours — Annunciator "SM Isolation Valves Not Fully Open" was received in the control room. The OATC observed MSIV 2SM-1 in the intermediate position and closing.

0130:23 hours — The OATC immediately initiated a manual reactor trip to preclude an automatic trip. All control rods fully inserted. The main turbine automatically tripped on the reactor trip signal.

0130:31 hours — The motor driven CA pumps autostarted due to receipt of a low steam generator level signal.

0130:39 hours — CF supply to the steam generators isolated due to receipt of a reactor trip with low NC system average temperature signal.

0130:40 hours — The turbine driven CA pump autostarted due to receipt of a low steam generator level signal.

Immediately following the manual reactor trip, Operations personnel entered procedure EP/2/A/5000/E-0 to verify proper response of the automatic protective systems. Transition to EP/2/A/5000/E-0.1 occurred to stabilize and control the plant. Unit 2 was stabilized in Mode 3.

0157 hours — During performance of EP/2/A/5000/E-0.1, steam generator (S/G) level was increased above the low level setpoint, CA was reset, and CA flows were throttled to prevent overcooling the NC system. S/G level was being maintained at approximately 40 percent. Procedural guidance is 9 to 62 percent. S/G "2D", the S/G isolated by the closure of 2SM-1, level inadvertently decreased below the low setpoint and a second CA autostart occurred. CA flow was increased to S/G "2D" to increase level above 37 percent low level setpoint. CA was reset.

Engineering and Maintenance initiated the FIP process to determine the cause of the closure of MSIV 2SM-1.

1500 hours — Engineering and Maintenance systematically reviewed and tested the components in the control circuitry of MSIV 2SM-1. No failed or degraded components were identified.

1956 hours — A second test was performed on the DOIs using an oscilloscope. The Maintenance specialists observed spiking during the inspection of DOI 2SMID2 (IO) in the "B" train non-safety circuitry. The spikes were erratic with the DOI output returning to within the acceptable range following the spikes.

August 18, 1997

0128 hours — The DOI exhibiting erratic output was replaced per Work Order 97071099-01. The extended testing was performed on the DOIs on the other three Unit 2 MSIVs. No degradation was observed.

0505 hours — As a conservative measure, Station Management and Engineering concluded that MSIV DOIs with an identification date of August 1995 or November 1995 would be replaced.

1506 hours — DOI 2SMID4 (CX) in the control circuitry of MSIV 2SM-3 was replaced per Work Order 97071254-01. DOIs 2SMID6 (CW) and 2SMID7 (IN) in the control circuitry of MSIV 2SM-5 were replaced per Work Order 97071253-01. DOIs 2SMID8 (CV) and 2SMID9 (IM) in the control circuitry of MSIV 2SM-7 were replaced per Work Order 97071252-01.

2155 hours — Unit 2 was restarted.

CONCLUSION

The events described in this Licensee Event Report (LER) were caused by the failure of E-Max digital optical isolators. The DOIs in question are model number 175C156.

The failed optical isolator from the July 1997 event was analyzed at the Duke Power Testing Laboratory. This inspection concluded that the failure was related to a resistor which had overheated. Both failed optical isolators noted in this LER have been sent to Performance Improvement International (formerly Failure Prevention and Investigation International)

for additional analysis to determine the failure mechanism internal to the DOI.

Corrective actions for the July 26, 1997, event included replacement of the failed DOI in the "A" train control circuitry of MSIV 2SM-1 and testing of the optical isolators on the remaining Unit 2 MSIVs. This testing revealed no degradation in the other optical isolators.

During the investigation into the August 17, 1997, closure of 2SM-1, Maintenance was unable to identify component failure or degradation during their first inspection with a digital multimeter. During the second analysis of DOIs using an oscilloscope, the specialists noted momentary fluctuations in the output of DOI 2SMID2 (IO). Following the fluctuation, the output would return to less that 4 vdc which is within the acceptance range.

The test method used to identify the degraded DOI was different from the standard test method in that the control circuitry had been energized a longer period of time (1 to 2 hours) and the output readings were taken over a fifteen minute period. The prior method of testing which was developed with the vendor's concurrence did not monitor the circuit for a period of time long enough to identify degradation resulting in the failure mode that was being experienced. The DOI vendor concurred that the revised testing method was capable of identifying degradation associated with this failure mode.

All Unit 1 and Unit 2 DOIs in MSIV applications have been tested using the newer test method. All were found to be within specification. The failed DOIs had identification dates of August 1995 and November 1995. As a conservative measure all DOIs in MSIV applications with these identification dates were replaced.

Planned and in-progress corrective actions include frequent testing of DOIs in MSIV applications until the failure mechanism internal to the DOIs can be determined, testing of all E-Max model number 175C156 DOIs having AC input and DC output in critical control applications, additional failure analysis by Performance Improvement International and the DOI vendor, and an audit of the DOI vendor's manufacturing process. Additional corrective actions will be assigned as necessary following completion of this investigation.

The failure of E-Max digital optical isolator model number 175C156 is Nuclear Plant Reliability Data System (NPRDS) reportable.

The DOI failures noted in this LER meet the recurring event criterion noted in Duke Power procedure SRG 3.2, Licensee Event Report.

Additional review of reportable events found a past event involving an optical isolator failure. This event did not occur within the recurring event analysis period noted in SRG 3.2. SRG 3.2 specifies analysis of events occurring within 24 months of the current event. However, this event is included due to its relevance to the current events. A Unit 2 reactor trip occurred on February 22, 1995, due to failure of an E-Max model 175C156 optical isolator in the control circuitry of MSIV 2SM-5. This event is documented in LER 414/95-001. This event was attributed to the failure of a capacitor in the optical isolator. This is different from the current events which were attributed to resistor failure. Corrective actions associated with LER 414/95-001 included development of an enhanced preventive maintenance program, replacement of all DOIs with AC input and DC output in a critical control application with DOIs with a more reliable capacitor, and establishment of a trending program for analog and digital optical isolators.

The optical isolators involved in the current events contained the more reliable capacitor. There have been no failures of DOIs in critical control applications due to capacitor failures following the extensive DOI replacement project. The overall failure rate of DOIs since the replacement project has been very low. However, as noted above, the current failures are associated with a resistor in the optical isolator.

CORRECTIVE ACTION

IMMEDIATE - July 26 and August 17, 1997 Events

1) The Operator At The Controls manually tripped the reactor upon verification of 2SM-1 closure.

2) Reactor Operators entered procedures EP/2/A/5000/E-0 and EP/2/A/5000/E-0.1 to evaluate, stabilize, and control the unit.

SUBSEQUENT - July 26, 1997 Event

1) The Failure Investigation Process was initiated to determine the cause of MSIV 2SM-1 closure.

2) The FIP identified an optical isolator in MSIV 2SM-1 circuitry as failed. Replacement and testing of the failed isolator was performed under Work Order 97064125-01.

3) Work Orders 97064150-01, 97064149-01, and 97064148-01 verified that the optical isolators for MSIVs 2SM-3, 2SM-5, and 2SM-7, respectively, were not degraded.

4) Testing of the failed optical isolator for 2SM-1 by the Duke Power Testing Laboratory identified an open circuit on a resistor.

SUBSEQUENT - August 17, 1997, Event

1) The Failure Investigation Process was initiated to determine the cause of MSIV 2SM-1 closure.

2) Maintenance and Engineering identified a better method of testing for the failure mode being experienced. This method identified DOI 2SMID2 (IO) in the "B" train non-safety circuitry as being degraded. This DOI was replaced per Work Order 97071099-01.

3) Testing was performed on the DOIs on the other three Unit 2 MSIVs and all Unit 1 MSIVs. No degradation was observed.

4) DOIs in a MSIV application with an identification date of August 1995 or November 1995 were replaced as a conservative measure.

PLANNED

1) DOIs in a MSIV application will be tested at a frequency determined by Engineering until the failure mechanism internal to the DOI can be identified.

2) All E-Max model number 175C156 DOIs with AC input and DC output in critical control applications will be tested.

3) The failed optical isolators have been sent to Performance Improvement International for additional failure analysis.

4) The DOI vendor is investigating the failures.

5) An audit of the vendor's manufacturing process will be performed.

6) Engineering will develop additional corrective actions as necessary following completion of the additional failure analysis.

7) The Operations group will evaluate the second CA autostart which occurred during the August 1997 event and determine programmatic

enhancements to prevent recurrence. This evaluation will be performed as part of the corrective action process and documented in Problem Investigation Process 2-C97-2684.

SAFETY ANALYSIS

The manual reactor trips described in this LER occurred with Unit 2 in Mode 1 at 100 percent power level. The manual reactor trips were initiated to preclude automatic trips on Over Power Differential Temperature or Over Temperature Differential Temperature trip setpoints being received from increased steam flow on the other three SM loops following closure of MSIV 2SM-1.

Analysis of the events by Engineering personnel indicated that safety systems operated as designed. Diagnosis and response to the MSIV closure by Operations personnel was correct.

This event is bounded by the discussions contained in the Updated Final Safety Analysis Report in section 15.2.4, Inadvertent Closure of Main Steam Isolation Valves, and section 15.2.3, Turbine Trip.

The health and safety of the public were not affected by this event.